HISTORY and DISTRIBUTION of EURASIAN WATERMILFOIL in UNITED STATES and CANADA

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Watermilfoils have frequently been problems in ponds, lakes and canals throughout North America in the past, but in the late 1950's and 1960's, they became serious ecological problems in much larger bodies of water, as in the Potomac River, Chesapeake Bay and TVA reservoir. From the early 1800's Myriophyllum spicatum L. had been listed as the species causing the problem. In 1919 Fernald separated all North American plant-specimens from the Eurasian specimens, calling them M. exalbescens Fern. Since 1919 most authors of floras, including Fernald, have used M. exalbescens for all American material, ignoring M. spicatum completely. However, both do existin North America, typical M. spicatum being the species which caused the recent problem.

The purposes of this paper are to establish the fact that both Myriophyllum spicatum L. and M. exalbescens Fern. exist in United States and Canada, to review the literature for usage of M. spicatum L. in North America in the past, to account for the recent explosive growth of M. spicatum L. in Eastern United States in the 1950's and 1960's, and to cite the herbarium specimens collected from that time up to date (mainly in the Reed Herbarium), showing the extent of the spread of M. spicatum L. as an economically important and ecologically dangerous waterweed.

Taxonomic considerations

Eurasian watermilfoil (Myriophyllum spicatum L.) was described by Linnaeus (Sp. Pl. 2: 992. 1753), based on specimens from Europe, from quiet waters, as a perennial.

In North America, Asa Gray (1848, p. 140) listed M. spicatum L. from northern United States. Tatnall (1860. p. 98) suggested M. spicatum L. probably could be found in New Castle Co., Dela., without any definite record of specimens. Again, Gray (1867, 1880 and 1887) and Robinson & Fernald (1908, p. 604) give M. spicatum L. from northeastern United States, this time stating it as being introduced from Europe. Probably all these references should be considered the plant now called M. exalbescens Fern. However, some of these early specimens have turned out to be M. spicatum L.

Ward (1881, pp. 24, 80, 160) was the first to cite definite specimens (No. 303) of M. spicatum L. from the Potomac River (below Alexandria and opposite Ft. Foote), presumably from the Virginia side of the river. Ricker (1906, p. 84) also cited specimen No. 303 as M. spicatum L. from Potomac River. Hitchcock and Standley (1919) added Hunting Creek (Va.) for this species, noting "widely distributed in North America, Europe and Asia", thus placing typical M. spicatum with all other North American material, most of which was later to be placed in M. exalbescens.

Fernald (1919) clearly indicated that American plants differed in several aspects from Eurasian specimens, and named the American material M. exalbescens Fern., without indicating that some of the material could be typical M. spicatum L. Hulten (1947) regarded M. exalbescens as a subspecies, namely M. spicatum subsp. exalbescens (Fern.) Hult. Löve (1961) discussed the situation and found that both had 2n=42 (hexaploid) chromosomes, but suggested the two names be retained for the different populations. (Löve originally (1948) recorded from Icelandic specimens 2n= ca. 36 for M. spicatum L.; later (1954) be corrected it to 2n= 28; and finally 'with better fixed material from Iceland' decided 2n=42, which is the same number as M. exalbescens Fern. from Lake Manitoba, Canada).

In giving the details of morphological differences between the two species, Löve says nothing about the plants of the Chesapeake Bay region, Potomac River or Tennessee Valley region. Plants from these areas do fit his description of M. spicatum L. and not for M. exalbescens Fern. This is important since Fernald (1950), Gleason (1952), Love (1961)and many others since then have assumed that all plants in North America, except some from Alaska and the Aleutian Islands, are M. exalbescens, noting 'M. spicatum of Amer. auth., not L.'.

Gleason (1952) added, 'perhaps better subordinated to the Eurasian M. spicatum as var. exalbescens (Fern.) Jeps. Patten (1950) noted 'there exists a possibility that M. exalbescens Fern. and M. spicatum var. capillaceum Lange are the same, since both of these description were based, in part only in the former instance, upon material from Greenland. This would invalidate Fernald's name in the varietal category through precedence'. Therefore, M. spicatum subsp. exalbescens (Fern.) Hult. has been suggested.

Reed (1970) was the first to treat both species as being in North America. The annotated list of specimens below indicates those plants definitely identified as M. spicatum L. in North America, most of which have been collected since the Eurasian Watermilfoil explosion in the Chesapeake Bay, Potomac River and Tennessee River Valley regions.

Myriophyllum spicatum L.

Perennial, aquatic-rooted herb, reproducing by seeds, but very commonly and most efficiently spreading by rhizomes, fragmented stems, and axillary buds that occur throughout the year; stems long and branching, often from a depth of 5 m., most frequently to 1.6 m.), often forming extensive mats at the surface of the water, brick-red or olive-green in dried specimens; leaves whorled in 3's or 4's, to 35 mm. long, the principal leaves of the primary stems with 14-21 pairs of rigid slenderly linear divisions; bracts rhombic-obovate to elongate, the bractlets nearly round or kidney-shaped, broader than long, 0.5-0.8 mm. long; spikes terminal, 2.5-10 cm. long, often standing above the water level, after pollination then resubmerging; flowers (after emergence) with the stigmas ripening well in advance of the stamens (favoring cross-pollination); petals deciduous before ripening of the stamens; anthers linear, 1.8-2.2 mm. long; floral bracts longer than the fruits; schizocarp 4-locular, with 4 seeds; mericarps spherical, 4-angled, 2.5-3 mm. in diameter. Late July - September.

In fresh and saline waters, on muck to hard-packed sand; most common and a nuisance, especially to sportsmen. Native of Eurasia and parts of Africa. In many distinct areas of Eastern and Central United States, as far west as Wisconsin and Texas; distinct area in west-central California.

Myriophyllum exalbescens Fern.

Perennial aquatic herb, reproducing by seeds, running rhizomes and fragments of the stems; stems simple or forking, purplish, when dry becoming white, up to 1 m. in length; leaves whorled, in 3's and 4's, 1.2-3 cm. long, with 6-11 (-14) pairs of capillary flaccid or slightly stiffish divisions, the primary leaves submersed, 1-5 cm. long, 1.4 cm. broad;spikes almost naked, terminal, with the flowers in whorls, the lower flowers pistillate, the upper staminate; bracts persistent, rarely equaling the fruit, spatulate-obovate or oblong-shell-shaped, 0.8-1.8 mm. long, the lower serrate, the upper entire; bracteoles ovate, entire, 0.7-1 mm. long; petals oblong-obovate, concave, 2.5 mm. long; anthers 1.2-1.8 mm. long; schizocarp nearly globose, very slenderly 4-sulcate, 2.3 3 mm. long; mericarp rounded on the back, smooth or roughened. July - September.

Lakes, ponds, pools, and quiet waters, often brackish or calcareous; especially troublesome around edges of lakes. Native, throughout the northern part of the United States, south to Delaware on the east coast and to the Mexican border on the west; south into northwestern Mexico and north into Canada, from Newfoundland and Labrador to Alaska; Greenland.

Myriophyllum spicatum L. Eurasian watermilfoil. *A*. Habit—× 0.5; *B*, Whorl of leaves—× 2; *C*, part of flower spike, with pistillate flowers below and staminate flowers above—× 4; *D*, immature fruits—× 4; *E*, mature fruit—× 4.

Patten (1954) made a comprehensive study of the floral characters for several populations of the M. spicatum-complex from lakes in New Jersey, and suggested that, in addition to the variations already known in Eurasian representative specimens noted by Hegi (1926), there were considerable intergradings between North American specimens of M. spicatum and M. exalbescens. Leaves of both vary from soft to stiff, the leaflets from straight to curved, either slumping together, as a feather, or remaining separate when taken from the water; stems of both vary from light green to pinkish or reddish, those of M. spicatum tending to be brighter green, and only occasionally whitened.

Introduction, Ecology and Spread of M. spicatum

Many aquatic plants have been and are still grown as aquarium plants. Eurasian Watermilfoil (M. spicatum L.), Parrotfeather (M. aquaticum (Vell.) Verdc. -- syn. M. brasiliense Cambess. and M. proserpinacoides Hook. & Arn.) and Anacharis canadensis (Michx.) Rich. (Elodea canadensis Michx.), are a few of the more common species used in aquaria. Over the years people wishing to dispose of unwanted aquarium contents, have dumped fish, snails and plants into various water sources, as old quarries, reservoirs, ponds, lakes, streams amd rivers. For example, before they were filled in and built over, the auther collected all of these plants in the 1930's and 1940's from the limestone quarries near Cockeysville, Padonia and Texas, Baltimore County, Maryland. By the way, all these quarries drain into tributaries of the Big Gunpowder Falls which ultimately forms the Gunpowder River south of Joppatowne.

Barnes (1960) noted Eurasian Watermilfoil in the Chesapeake and Ohio Canal, near Cabin John and the Seven Locks area as early as 1945. Bertholdt (1958) wrote an article, stating "Your aquarium needs Myriophyllum -- plant of delicate beauty". Many aquarium magazines list Myriophyllum for sale. And, it is well-known that the vast growth in the TVA area in Tennessee was the result of plants introduced for the aquarium business.

The spotty distribution (see map) of authentic specimens of Eurasian Watermilfoil, in the past, would indicate independent introductions, probably from aquarium sources, from Canada to Florida, and occasionally westward.

The earliest published record for M. spicatum L. in the Potomac River is that of Lester Ward (1881), who wrote "Found in former years below Alexandria by Mr. Anton Zumbach. Probably still there" (p. 80). On p. 24, "Opposite Ft. Foote". Then in the Checklist following the Guide, on p. 116, "No. 303. Myriophyllum spicatum", a cited specimen. This reference would indicate the plant was in the Potomac River below Washington, D.C. previous to 1881.

Early Annotated Herbarium Specimens and Records

(1881 - 1953)

1881. Below Alexandria, Virginia. Anton Zumbach; opposite Ft. Foote. (Potomac River). (Ward, 1881).

1902. In lake-like expanse of Sundrake's Creek, Gunpowder River (Chesapeake Bay). Sept. 6, 1902. Geo. H. Shull 327. (US).

1915. Hunting Creek, Virginia. (Potomac River). Sept. 4, 1915. W.L.McAtee 2340. (Patuxent Refuge Coll.).

1933. Creeks in Upper Potomac River. Francis M. Uhler. (U.S. Fish & Wildlife Service (Unpubl. data), cited by Springer, Beaven & Stotts (1961) and D. Haven (1962).

1937. Cecil Co., Maryland. (Chesapeake Bay, shore of Turkey Point, Susquehanna Flats). June 18, 1937. J.B.Egerton & C.F.Reed. (Reed).

1949. Montgomery Co., Maryland. C. & O. Canal. Well-established. Oct. 1, 1949. F.H.Sargent. (Cath. U. -- annotated by C.F. Reed in 1962). (M. aquaticum also well-established at this time and collected).

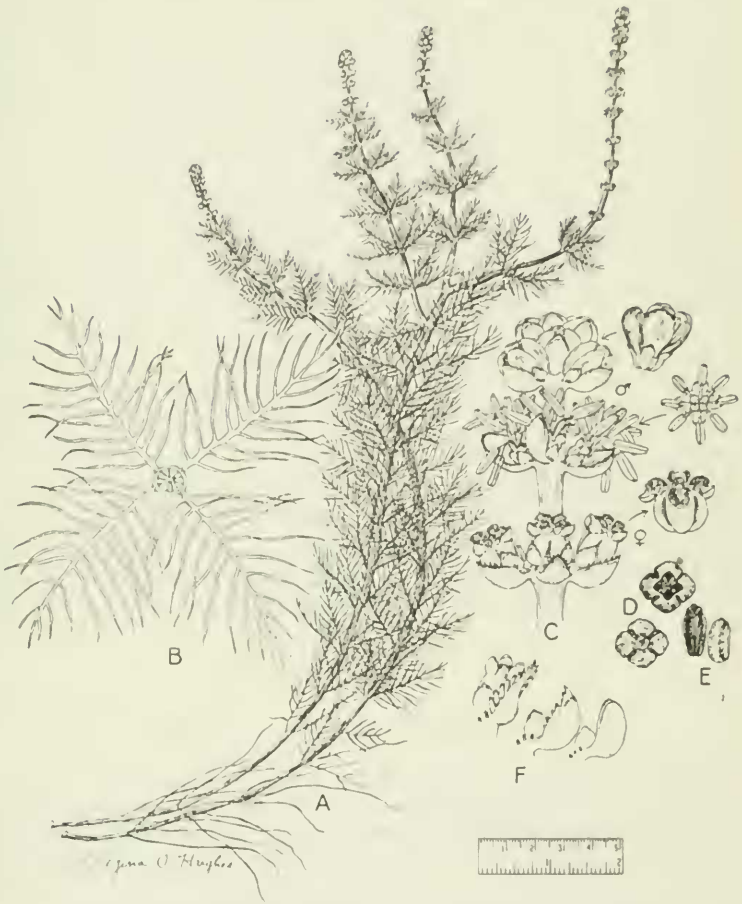
1951. Montgomery Co., Maryland. C. & O. Canal between Locks 10 and 12, abundant. Aug. 10, 1951. E.P.Killip 41366. (US).

1952. Charles Co., Maryland. In Potomac River, along shore, Chapel Point. Mar. 29, 1952. Reed 28087.

Ecology

Most Myriophyllum species have definite affinities for alkaline situations, and under high calcareous conditions in ponds, lakes and quarries, they precipitate encrustations of marl on their surfaces of the stems and leaves giving a white appearance. This condition is found quite frequently on specimens of M. exalbescens throughout North America, as well as on many of the specimens of M. spicatum from lakes and ponds in both North America and Europe.

Patton (1956) noted that "M. spicatum (var. exalbescens) was instrumental in maintaining a high pH, and that the daily pH cycle was so closely related to the physiological activities of the plant that only a 3.8 unit fluctuation occurred, the minimal and maximal of pH corresponding directly to photosynthetic activities. During the period of highest pH and maximum photosynthesis bicarbonate alkalinity dropped concomitant with the appearance of several ppm. of carbonate, indicating photosynthetic utilization of half-bound carbon dioxide".



Myriophyllum exalbescens Fern. Northern watermilfoil. *A*, Habit—× 0.5; *B*, whorl of leaves—× 1.5; *C*, flower spike, with male and female flowers—× 5; *D*, schizocarps—× 5; *E*, mericarps—× 5; *F*, bracts—× 5.

Although Eurasian Watermilfoil tolerates a broad range of ecological conditions, it is absent from acid waters. Maximum density of growth occurs in areas of fine organic ooze with a muck or sandy-muck base, diminishing to near total absence on pure sand. In grows in inland alkaline waters with a pH of about 8, and can tolerate tidal waters with salinity up to 16 ppt, or about 46 percent of sea salinity; plants can retain growing tips at 93 percent of sea salinity. Plants root best (experimentally) at salinity of 3.5 ppt. (10 percent of sea salinity), and will make good growth at 15 ppt. (43 percent of sea salinity).

Eurasian Watermilfoil is adaptable to rooting at varying depths of water to 3 m. (rarely to 5 m.), with its long branching stems reaching the surface of the water level, but never extending beyond the water level, as they do in M. aquaticum. Most plants are found attached in water 65-150 cm. in depth. Stems and leaves are usually dark to medium bright green in deep water, and both may become encrusted with algae and diatomaceous scum. In winter the upper portions of the stems break up and float about with the tides, each segment being capable to root and start a new colony. By May or June free floating rooted segments are common in the water. Being perennial, the lower portions of the plants remain green throughout the winter and send up new shoots in the spring and summer. In mild winters and in more southerly regions, floating stems can be seen year round (note dates on annotated specimens). Summer growth is very rapid, measured growth being 5-7 cm. per day. New Plants form readily by fragmentation and long stems may take root anywhere along their length. Special buds at the stem-tips are formed to produce new plants after the natural breakup of the beds in winter. Plants also produce seeds during the summer and early fall.

Explosive Growth and Distribution in Late 1950's

In 1962, in the Summary of the 1962 Interagency Research Meeting on Eurasian Watermilfoil, Reed 'pointed out that in Maryland all heavily infested waters receive their runoff from limestone areas. This also is true of the TVA and other areas where the plant is abundant. He felt that the presence of calcium ions may be an important factor in milfoil abundance. He also noted that the great reduction of coal-mining in Pennsylvania had removed quantities of acid waters from the Susquehanna and that contributions of calcium ions from that stream may have been sharply increased during recent years, thus favoring milfoil growth in the Upper Chesapeake".

When Eurasian Watermilfoil reached Cheaspeake Bay and the Potomac River region, ideal conditions were present -- calcareous waters (Shenandoah River drains off the limestone areas of north-central Virginia into the Potomac, Hagerstown Limestone Valley and along the Potomac and areas of Loudoun County, Virginia; large areas of Pennsylvannia and New York drain limestone waters into Susquehanna River, and then to Susquehanna Flats at the head of Chesapeake Bay; Gunpowder River drain the rich limestone areas of Cockeysville and Texas, Baltimore County, Maryland; Tennessee Valley drains large calcareous areas of Virginia, Kentucky and Tennessee) and calcareous beds (oyster beds along the Potomac River and various areas along Chesapeake Bay), deep organic ooze over the oyster beds, favorable pH ranges, warmer water temperatures of the lower Potomac River drainage and Chesapeake Bay, and the adaptability to the salinity of these regions. This combination of conditions led to the explosion in growth of M. spicatum in these regions in the 1950's and early 1960's.

Most of these conditions had been present to some degree in the Chesapeake Bay and lower Potomac River for many years, and M. spicatum in one or anothers of its forms had been known and collected there since 1881.

It is interesting to note here that rivers draining from non-calcareous areas into Chesapeake Bay (as Patapsco, Patuxent, Elk, Bohemia, Sassafras, Choptank and Wicomico (Wicomico Co.) Rivers) do not have M. spicatum, even though each is tidal for a for a portion of its distance. The acidity of these rivers, all draining over acid rock or sand, probably prevents survival of segments which may have been brought by tidal action.

After 1960, M. spicatum spread down Chesapeake Bay into Virginia as far as Princess Anne County (Virginia Beach) and North Carolina (Currituck Sound), being found in areas with both salinity and calcareous conditions similar to those further north.

In a survey of Susquehanna Flats in 1957 by Robert E. Stewart and Paul F. Springer, no plants of M. spicatum were reported; in 1958, only one; but in 1959, it was found at 47 percent of the hundred stations examined. Dense stands were seen along the west side of Chesapeake Bay, some a mile long and one-eighth mile wide.

Preceding the growth explosion of M. spicatum in Chesapeake Bay and the Potomac River, there had been a prolonged period of natural ecological events -- hurricanes and tropical storms -- pushing more saline water up both more frequently and to greater distances than normal tides would do, and then bringing downstream higher concentrations of calcium ions as the result of the floods. The hurricanes, by raising the pH and the salinity at

the same time, especially in the upper reaches of the tidal portions of Chesapeake Bay (as Susquehanna Flats, mouth of Gunpowder River and most of the estuaries of tidal rivers in the Upper Chesapeake Bay) and the Potomac River up to Washington, D.C., and by pushing warmer waters into these areas (since most of the hurricanes occurred from Juen to October), provided ideal conditions for M. spicatum to grow vigorously, and it did from about 1957. Additional incentives for milfoil to spread were the whipping action of the hurricanes, the higher tides than normal, thus keeping maximum growth of milfoil at maximum ecological conditions, and man's intervention to control or irradicate it with mowing and cutting devices.

Recently, the National Hurricane Center, Coral Gables, Florida, provided the author with a list of the hurricanes from 1945-1967 which directly affected the Chesapeake Bay-Potomac River areas. They are listed below. Also many tropical storms, not listed as hurricanes, occurred during this time. For example, the Guiness Book of World Records cites as a world record 1.23 inches of rainfall in 1 minute at Unionville, Maryland at 3:23 P.M. on July 4, 1956, the most intense recorded in modern times. This area drains into the Potomac River.

Year	Date	Year	Date
1945	Sept. 18-19	1954	Oct. 15
1949	Aug. 28-29	1955	Aug. 12-13
1952	Aug. 31-Sept.1	1955	Aug. 17-19
1953	Aug. 13-14	1960	Sept. 12
1954	Aug. 30-31	1967	Sept. 16

Hurricane Hazel (Oct. 1954) , tropical storms Connie and Diane (Aug. 1955) and several flood-producing storms in 1956 probably set up ideal conditions on Susquehanna Flats snd along the Potomac River for M. spicatum to thrive and spread rapidly throughout the area from 1957 to 1959.

Previous to this period of hurricanes and tropical storms there had been several such flood-producing conditions in the late 1920's, up to the last big flood in 1936 (Hill, 1977). In the 1970's the most devastating hurricane and tropical storm in this area were Hurricane Agnes (June 21, 1972) and Tropical Storm Eloise (1975). Agnes wound up in Chesapeake Bay, and the declining salinity played havoc with the commercial seafood crops. Some say thay the bay has yet to return to pre-Agnes days. (Hill,1977).

Springer & Stewart (1960) made a study of the relation of precipitation and chlorine content of surface water at Conowingo (above tidal effects) and Turkey Point (near Susquehanna Flats), and found that where the chlorine content was lower than 0.04-0.07 percent of sea salinity, growth of milfoil was more abundant, as at Carpenter Point, Perry Point and Fishing Battery.

Beaven (1960) indicated that at times temporary relief from the plant could be provided by cutting. Various modifications of power-driven sicklebars, rotary cutters, chain saws and sharp V-shaped drags were devised and used by local interests. However, since the sut-off portions continued to grow and take root, much like the normal after-winter fragmentation of plants, control by cutting tended to spread the plant to new areas.

Milfoil can be spread by entanglement on boat proleppors, anchors, nets and other gear moved from one body of water to another.

Following physical means to erradicate milfoil, chemical techniques were considered. In 1960 and 1961, Springer, Beaven and Stotts reported that formulations of three esters of 2,4-D, applied in dosages of 20 lbs. a.e. per acre, gave almost complete control of milfoil, especially at temperatures of 18°C during the period from mid-May through the first week of June, or until flowering was initiated.

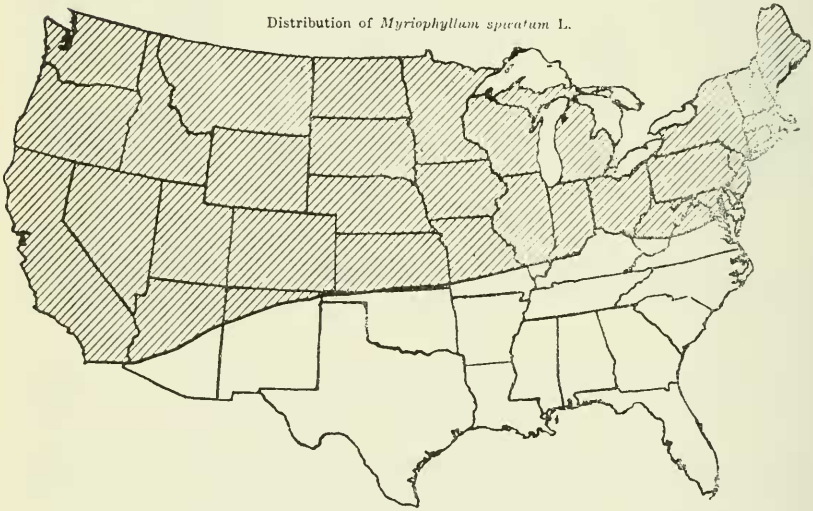
Decline in growth of milfoil in the Upper Chesapeake Bay after 1962 was attributed to various pathogenic agents by Bayley et al. (1968 and 1970) and Bean et al. (1973.

Since Agnes and Eloise, growth has been becoming gradually increasing. This spring in May and June, the author has been able to collect Eurasian Watermilfoil in all the old familiar places where it had been collected 15-20 years ago, and in some places it is rather frequent.

At present it seems that M. spicatum is at a static or low rate of growth, only awaiting the next cycle of ideal ecological conditions to start another explosive growth cycle. The plants are there, the conditions are not quite optimal.

Illustrations and maps from Selected Weeds of the United States, U.S.D.A., Agric. Handb. No. 366. 1970.

Distribution of *Myriophyllum spicatum* L.



Distribution of *Myriophyllum exalbescens* Fern.

Annotated Herbarium Specimens

(1954-1977)

MARYLAND

Hirzel (1962) stated 'more than loo,ooo acres of water in Maryland have been affected by milfoil. The plant has infested the Susquehanna".

Anne Arundel Co. -- Holly Beach at Rt. 50, Chesapeake Bay Bridge. June 15, 1970. Reed 88381 and 88383; shores of Little Magothy River at Cape St. Clair. June 15, 1970. Reed 88402. Covell (1961) stated "it has been found in the Magothy River, and in the Chesapeake Bay down to the Bay Bridge area".

Baltimore Co. -- Dundee Creek in very slightly brackish water. Aug. 10, 1960. F.M.Uhler et al. (US, F & WL); just E of Battery Point on west side of Gunpowder River. Aug. 25, 1960. N. Hotchkiss & G.H.Townsend 7670 (F. & WL); Galloway Cove, in 7 ft. of water. Aug. 15, 1960. G.H.Townsend. (F. & WL); Bird River near White Marsh. June 26, 1961. Reed 51126; Bird River Beach along Bird River. July 22, 1961. Reed 51410; along shores of Brown's Cove, branch of Middle River near Rocky Point and Cedar Point. Mar. 10, 1962. Reed 54154; along shore, Back River at Rocky Point. Mar. 10, 1962. Reed 54153; in shallow water at Rocky Point Cove, Back River. Mar. 10, 1962. Reed 54152; along Dundee Creek near Chase. Apr. 19, 1962. Reed 55784; Rocky Point on shore of Back River. July 8, 1963. Reed 64235; shores of Middle River at end of Kingston Road. July 8, 1963. Reed 64237; along Middle River at Wilson Point. July 8, 1963. Reed 64212 and 64213; along shore of Chesapeake Bay at Brown's Cove, near Breezy Point Park. Nov. 1, 1968. Reed; Dundee Creek near Chase. Oct. 24, 1970. Reed 87242; Dundee Creek, E of Chase, frequent. May 2, 1977. Reed 100560. Covell (1961) reported "it has flourished in Dundee and Saltpeter Creeks and is rapidly invading Middle River and other upper bay tributaries".

Calvert Co. -- Shore of Chesapeake Bay at Scientists Cliffs. Mar. 4, 1967. Reed 74496.

Cecil Co. -- Shores of Chesapeake Bay on Elk Neck at Hance Point. Aug. 23, 1962. Reed 58255; along beach at Charlestown. Nov. 23, 1962. Reed 59607; along shore of Elk River, Lewis Shore. May 25, 1963. Reed 62098; along Bohemia River at Rt. 213. May 25, 1963. Reed 62088; mouth of Northeast River at Charlestown, Susquehanna Flats. July 8, 1963. Reed 64335 and 64337; along Elk River off Elk Forest Road. May 25, 1963. Reed 62089; along Susquehanna River at Aiken, N of Perryville. July 8, 1963. Reed

64315; marsh along Bohemia River at Rt. 213 near Hanks Point. Aug. 28, 1968. Reed 95406; shores, Susquehanna Flats, Charlestown. June 15, 1968. Reed 77053; shallow water along shore, White Crystal, mouth of Elk River. Aug. 28, 1968. Reed 79603; White Crystal Beach, 6 mi W of Cecilton. June 18, 1977. Reed 100547; shore of Chesapeake Bay, Susquehanna Flats, Charlestown. June 18, 1977. Reed 100549; frequent along shore of Susquehanna River, head of Chesapeake Bay, Perryville. June 18, 1977. Reed 100550.

Charles Co. -- Covell (1961) reported " it forms dense beds in Nanjemoy, Picowaxen and St. Patrick's Creeks, and in Port Tobacco and Wicomico Rivers, and in Neale and St. Catherine Sounds". In Potomac River along shore, Chapel Point. Mar. 29, 1952. Reed 28087; West Hatton Point, Wicomico River. Oct. 22, 1957. R.E. Stewart. (F. & WL); in Mattawoman Creek near Mason Springs Swamp at Rts. 224-225. Oct. 27, 1963. Reed 64915; same area. May 18, 1969. F.M.Uhler. (Reed); exposed at low tide, Port Tobacco River, cove at Brentland Wharf. May 30, 1969. F.M.Uhler (Reed).

Harford Co. -- Abington Beach on Bush River. July 8, 1963. Reed 64314; Otter Point on Bush River. July 8, 1963, Reed 64304; shore of Chesapeake Bay, S of Harve de Grace. Dec. 11, 1965. Reed 72271; Otter Point on Bush River. May 2, 1977. Reed 100561; Spesutia Creek, attached to bottom, at Rt. US 40. May 14, 1977. Reed 100532; shore of Chesapeake Bay, Harve de Grave. June 18, 1977. Reed 100550. Springer & Stewart (1959-1961) made an extensive study of Susquehanna Flats off Harve de Grace to Spesutie Island.

Kent Co. -- Turner Creek off Sassafras River near Kennedyville. Aug. 2, 1965. J.Stennis & Ted Stiles (Reed); frequent along shore of Chesapeake Bay, mainly rooted fragments, Betterton. June 18, 1977. Reed 100546.

Montgomery Co. -- Abundant in C. & O. Canal, 1 mi W of Cabin John. Nov. 2, 1957. N. Hotchkiss 7594. (F. & WL.).

Queen Annes Co. -- Flats in Northern Maryland, Maryland's Eastern Shore as far south as Kent Island near the Chesapeake Bay Bridge, and much of the western shore of Maryland from the Upper Bay to the Potomac River.

St. Marys Co. -- Piney Point. 1959. Reported by Springer & Stewart (1960).

VIRGINIA

Dexter Haven (1962) found M. spicatum in nearly every tributary of the Virginia shore of the Potomac River, being most abundant in Hack, Lower Machodoc, Nomini, Popes, Mattox and Nossier's Creeks.

Westmoreland Co. -- In 5-6 ft. of water, Cabin Point Cove, Lower Machodoc Creek. May 23, 1960. John Steenis, J.Gallagher & Jerry Townsend. (US); same locality. June 5, 1959. Dexter Haven; shore of Potomac River at Colonial Beach. Jan. 27, 1963. Reed 60176; same locality. April 18, 1970. Reed 85653;

Princess Anne Co. -- (Virginia Beach). In marsh and ditches. Middle Creek Road, N of Back Bay. June 28, 1970. Reed 94127, 94142, 94134; sandy waste, Back Bay Wildlife Refuge. June 30, 1970. Reed 94146.

NORTH CAROLINA

Currituck Co. -- Edge of water, sound, Rt. 34 at Currituck. Aug. 7, 1968. Reed 77484; Currituck Sound. Sept. 21, 1974. James A. Duke 17310 (Reed). John Steenis (1962) reported it in Pea Island Refuge on the outer banks.

Annotated Specimens of M. spicatum

Other localities of interest

California: Mountain Lake, San Francisco Co. June 1891. Michener & Bioletti. (Cath. U., Langlois).

Vermont: Franklin Co. Lake Champlain at St. Albans Bay, common here. July 9, 1965. Wm. D. Countryman1281. (F. & WL.).

Massachusetts: Fresh Pond, Cambridge. Aug. 11, 1879. Ex Herb. Thomas Morong. (Cath. U., Langlois).

Minnesota: Lake Collegeville. June 22, 1909. Jas. Hansen 281. (Cath. U., Langlois).

New Jersey: Hunterdon-Somerset Co., in flowing water a long Three Bridges Creek near Woodfern. July 12, 1962. Reed 57716 and 57723.

Pennsylvania: Common in shallow water along south shore of Lehigh River, opposite the foot of Jeter Island, Allentown. June 27, 1963. N. Hotchkiss 7857. (US, F. & WL.).

New York: Paddy's Lake near Oswego. Sept. 1882. J.Herman Wibbe. (Cath. U., Langlois).
Monroe Co.: Riley's Pond, Cobb Hill Park, Rochester. July 11, 1960. Ronald A. Ulrich. (F. & WL.).
Seneca Co.: Seneca River at Waterloo. July 25, 1960. Ronald A. Ulrich. (F. & WL.); north end of Seneca Lake, Rt. 5. Aug. 18, 1962. Reed 58277.
Jefferson Co.: Westcott Beach, Lake Ontario, Thousand Island State Park. July 17, 1963. Reed 65823.
Cayuga Co.: Along bay of Lake Ontario, Fairhaven. July 16, 1963. Reed 65809.
Schuyler Co.: Along canal between Weneta and Lamoka Lakes, near Weston. Sept. 7, 1963. Reed 64019; Waneta Lake, S of Wayne. Sept. 7, 1963. Reed 64002 and 64006.
Wayne Co.: Occasional small plants, flowering on muck among scattered other plants, Sawmill Cove, SW side of Sodus Bay, Lake Ontario. Sept. 12, 1960. N. Hotchkiss 7684. (F. & WL.); abundant on east side of Sidus Bay, just N of US Rt. 104 bridge, Lake Ontario. Sept. 12, 1960. N. Hotchkiss 7675 (F. & WL.); in Lake Bluff on Lake Ontario. July 16, 1963. Reed 65801 and 65803; swamp, Bay Bridge, Rt. 104, W of Alton. July 16, 1963. Reed 65819.

Ohio: Trumbull Co., in pond along N side of Ohio Turnpike, 1.5 mile SW of Lordstown. Sept. 4, 1962. P.F.Springer. (US, F. & WL.); Ottawa-Sandusky Co. line, abundant in gray silt in dike burrow pit on N side of Muddy Creek, SW of Port Clinton. Aug. 4, 1965. F.M.Uhler. (F. & WL.).

Tennessee: Rhea Co., Watts Bar Reservoir, Spring City. Nov. 1960. J.L.Frizzell. (US, F. & WL.).

Louisiana: Pointe Coupee Parish, False River near New Roads. July 1966. John W. Thieret. (F. & WL.).

Texas: Hays Co., occasional with dense other underwater vegetation in Aquarena Pond, San Marcos Spring, San Marcos. June 6, 1966. F.M.Uhler & N. Hotchkiss 8194. (F. & WL.); Burnet Co., common in hard-bottomed cove on E side of Inks Lake, Inks Lake State Park. June 8, 1966. Ulher & Hotchkiss 8204.(F. & WL.); Colorado-Fayette Co. line, filling a half-acre farm pond along Rt. 71, 12 mi. NW of Columbus. June 10, 1966. Ulher & Hotchkiss 8208. (F. & WL.).

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